Public workfare programs as agricultural insurance: Evidence from rural India, 2004-2012

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Motivation

- The incidence of droughts is frequent and heat waves last longer. Plot Drought
- Extended dry periods cause crops to fail. Staple crops Cash crops
- Market based insurance solutions are underdeveloped in developing countries.

Public workfare programs as agricultural insurance

- National Rural Employment Guarantee (NREG) scheme, 2005
  - 100 days of minimum wage paid public employment per fiscal year for all households in rural India.
  - Public projects such as road construction, and micro-irrigation ditches.
- NREG scheme was rolled in three phases.
- Workfare programs used largely as an outside option in rural areas. Plot Persondays 2006-10
- **Research question**: Can workfare programs serve as a substitute for weather insurance in rural areas of developing countries?

Relationship to previous work

- Higher temperature negatively affects crop yields (Schlenker and Robert, 2009)
- Weather fluctuations have a negative effect on the agricultural labor market (Jayachandran, 2006; Jessose et al. 2016; Colmer 2018).
- Impact of public workfare programs on labor market (Doug, 2009; Azam, 2012; Zimmermann, 2012, Imbert and Papp, 2015; Fetzer, 2019)

Contribution to the climate and development literature

- We examine how the existence of public workfare programs moderates the impact of non-linear weather variables on wages and employment sectors.
- We critically examine of the relationship between rainfall variability and wages and employment.
- We use a novel data set that integrates the spatial distribution of agro-climatic variables with nationally available employment and unemployment data at the district level (similar to a US county).

Labor reallocation decision: Set up

Two sectors in a two period model: ag (A) and non-ag (N)
The wage of individual i in sector $J(J = A, N)$ is given by:

$$w_i^J = \mu^J + \beta^J \varepsilon_i,$$

Baseline wage depends on climatic determinants, θ, through agricultural productivity. That is,

$$\frac{\partial \mu^A}{\partial \theta} < \frac{\partial \mu^N}{\partial \theta} < 0.$$

Switching cost, $c = c(c_{monetary}, c_{non-monetary})$

$$\mu^N(\theta) + \beta^N \varepsilon_i - c > \mu^A(\theta) + \beta^A \varepsilon_i$$

Rearranging, we get:

$$\varepsilon_i > \frac{\mu^A(\theta) - \mu^N(\theta) + c}{\beta^N - \beta^A}.$$

Labor reallocation constraints: Incentive and Feasibility

Incentive constraint defined as

$$\text{Share of reallocated workforce} = 1 - \Phi\left(\frac{\mu^A(\theta) - \mu^N(\theta) + c}{\beta^N - \beta^A}\right) \tag{1}$$

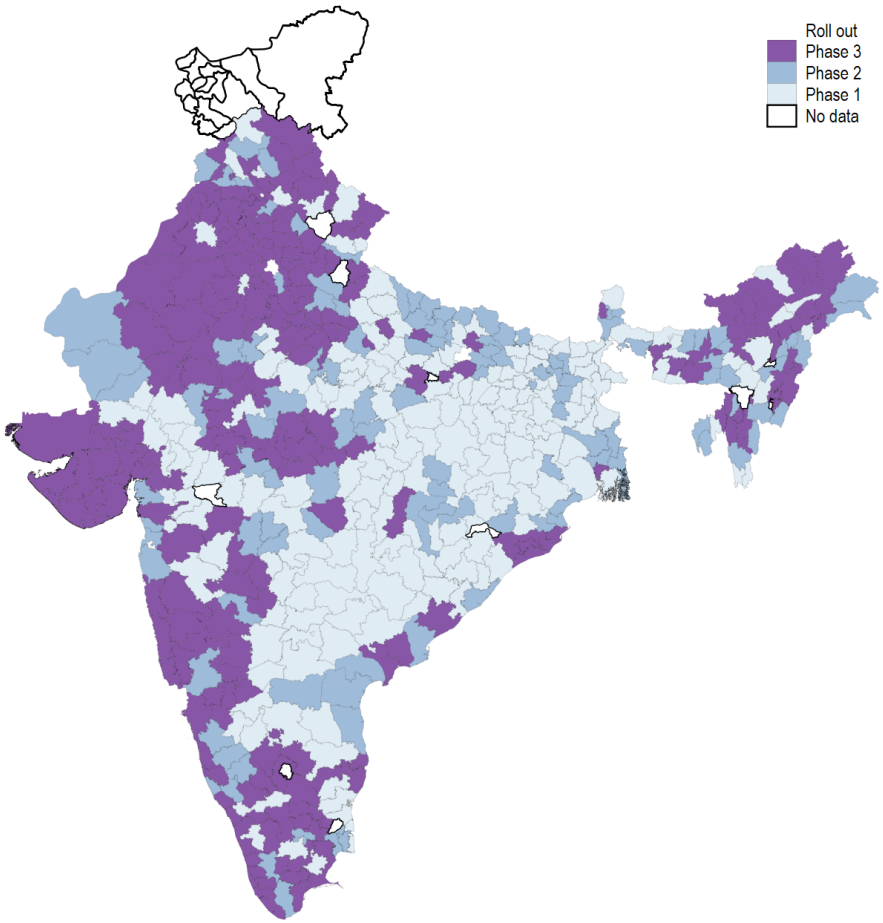
Feasibility constraint defined as

$$\text{Share of reallocated workforce} = 1 - \Phi\left(\frac{c - \mu^A(\theta)}{\beta^A}\right) \tag{2}$$

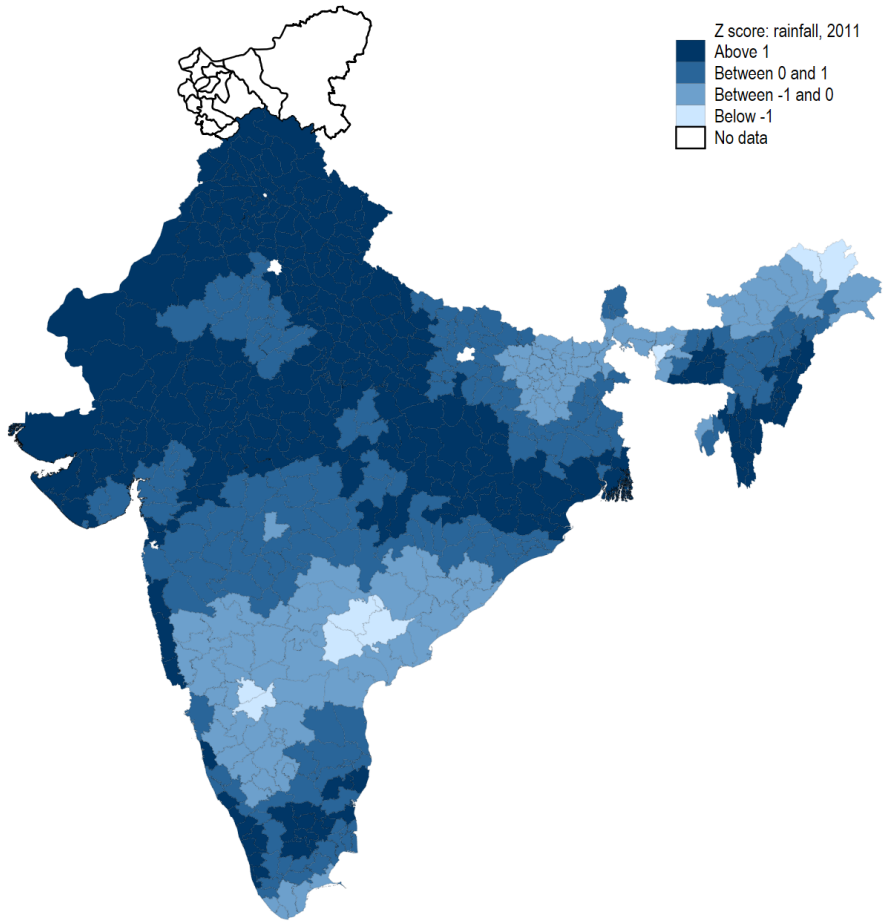
By taking logarithms and log-linearizing both sides of equations 1 and 2, we obtain the basic empirical equation:

$$ln(ShareEmp) = \alpha + \beta ln(\theta) + \gamma c.$$

Map of study area



(a) NREG phase-wise roll out



(b) Rainfall z score, 2011

Data

- Unit-level data from five rounds of National Sample Surveys on Employment and Unemployment Situation in India (NSS EUS). Survey round Descriptive statistics
- India Human Development Survey (IHDS) two waves conducted in 2004-05 and 2011-12 Plot income distribution
- Weather variables were obtained from NCMRWF and CHIRPS Plot person-days and rainfall Plot rainfall anomalies
  - June-September daily accumulated rainfall
  - June-September daily mean temperature

Empirical Specification: Wages and Employment

Base specification:

$$y_{dqt} = \beta_1 f(\theta_{dt}) + \beta_2 T_{dt} + \beta_3 T_{dt} * f(\theta_{dt}) + \alpha_d + \phi_{st} + \varepsilon_{dqt}$$

y_{dqt} is the outcome of interest in district d in quarter q in year t;

T_{dt} is the dummy variable, 1 if public workfare program is available in district d in year t;

$f(\theta_{dt})$ is a non-linear function of precipitation and temperature;

α_d is a vector of district fixed effects;

ϕ_{st} is a vector of state-year fixed effects;

ε_{dqt} represents error terms.

Effects of weather on average daily farm earnings (Rs., log)

	Peak season		Lean season	
	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun
Rainfall (Kg/m2, log)	0.147**	-0.026	-0.005	-0.054
	(0.058)	(0.053)	(0.049)	(0.058)
Degree days (DD)	0.504	-0.418	0.247	-0.202
	(0.403)	(0.440)	(0.358)	(0.425)
Square root Heat DD	0.016*	0.004	-0.015	-0.013
	(0.008)	(0.006)	(0.009)	(0.009)
	District and State-year FEs			
Observations	2057	2059	1955	1933
Number of districts	495	495	490	491

Conley standard errors in parentheses

Result non-agricultural wage rate

Effects of weather on share of agricultural employment

	Peak season		Lean season	
	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun
Rainfall (Kg/m2, log)	0.017	0.051**	0.011	0.012
	(0.025)	(0.024)	(0.021)	(0.030)
Degree days (DD)	0.261	0.123	-0.048	-0.008
	(0.199)	(0.164)	(0.156)	(0.196)
Square root Heat DD	0.008	0.000	0.001	-0.007*
	(0.005)	(0.004)	(0.005)	(0.004)
	District and State-year FEs			
Observations	2565	2560	2545	2560
Number of districts	513	512	509	512

Conley standard errors in parentheses

Result share of non-ag employment

Effects of NREG on average daily farm earnings (Rs., log)

	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun
Rainfall (Kg/m2, log)	0.163**	0.003	0.009	-0.073
	(0.070)	(0.064)	(0.061)	(0.062)
Degree days (thousands)	0.685	-0.391	0.370	-0.230
	(0.449)	(0.489)	(0.446)	(0.471)
Square root HDD	0.020*	-0.006	-0.019*	-0.017*
	(0.011)	(0.011)	(0.010)	(0.010)
NREG	-0.091	0.819**	0.174	-0.102
	(0.383)	(0.322)	(0.341)	(0.363)
NREG × Rainfall (log)	-0.016	-0.076**	-0.030	0.034
	(0.037)	(0.033)	(0.032)	(0.035)
NREG × Degree days	0.107	-0.097	0.002	-0.062
	(0.106)	(0.085)	(0.088)	(0.093)
NREG × Square root HDD	-0.004	0.004	0.003	0.011
	(0.007)	(0.007)	(0.006)	(0.007)
Observations	1949	1945	1837	1805
Number of districts	451	451	434	433

Robust standard errors clustered at the district level. Plot Marginal Effects

All regressions include district and state-year FEs.

Main Finding:

- In a district-years that have a workfare program available, wages remain higher suggesting the role of insurance.

Future Directions:

- Does workfare programs mitigate the effects of weather induced income shocks? Result Household income
- Explore treatment heterogeneity by gender and climatic zones.

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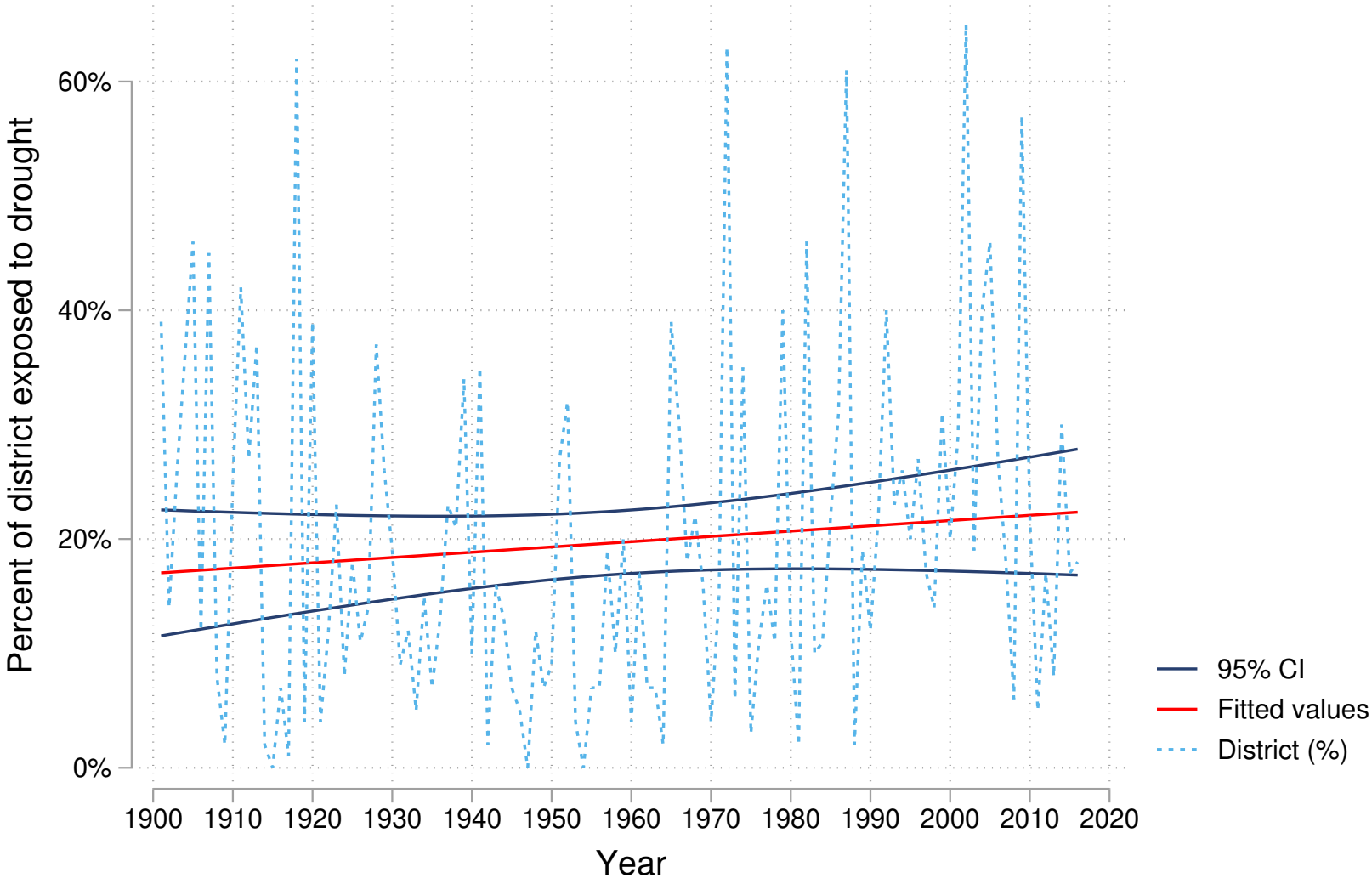

Figure: 1. Incidence of drought (rainfall below 20th percentile of long-run historical average) at the district level (based on 2011 India Census district geographic boundaries) between 1901-2016. (Source: CRU)

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Estimated coefficient for rainfall deciles on yields

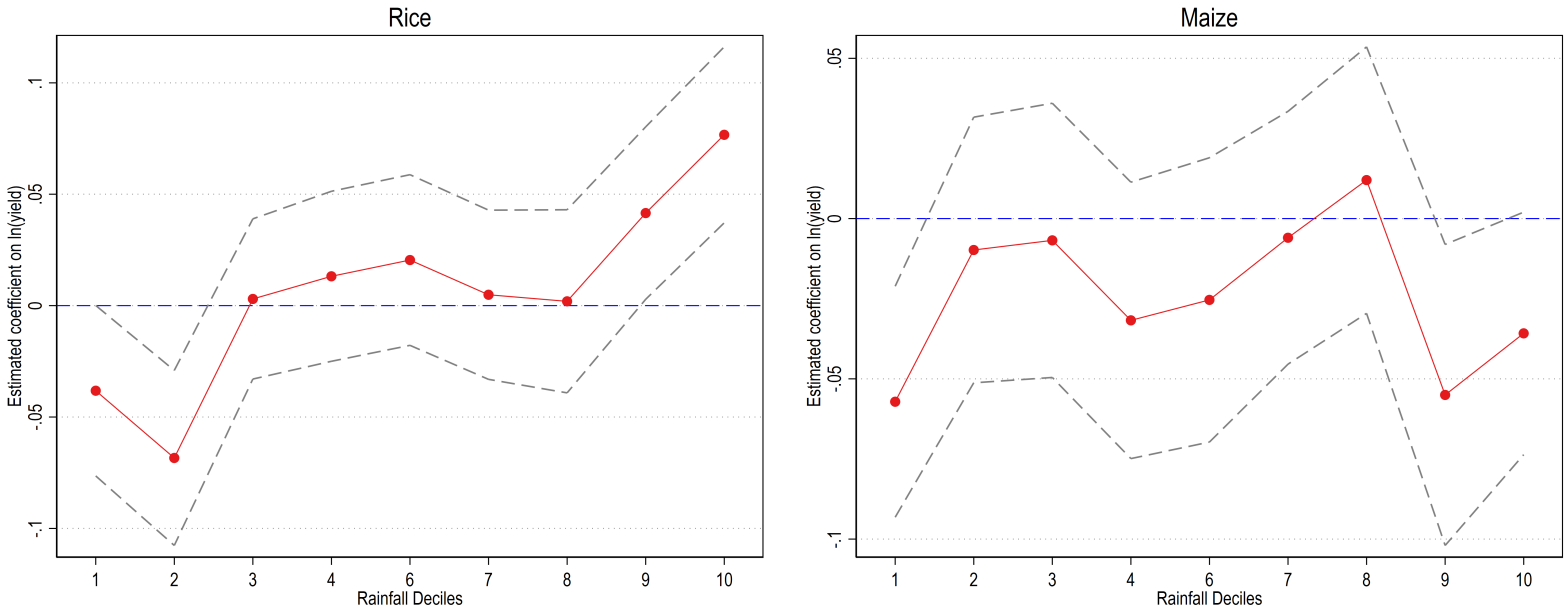

Figure: 2. The dependent variable is the natural logarithm of annual crop yield (kg per hectare) from 2001 to 2015. The specification include non-linear temperature controls, and district and year fixed effects. The 5th decile is selected as reference.(Source: ICRISAT)

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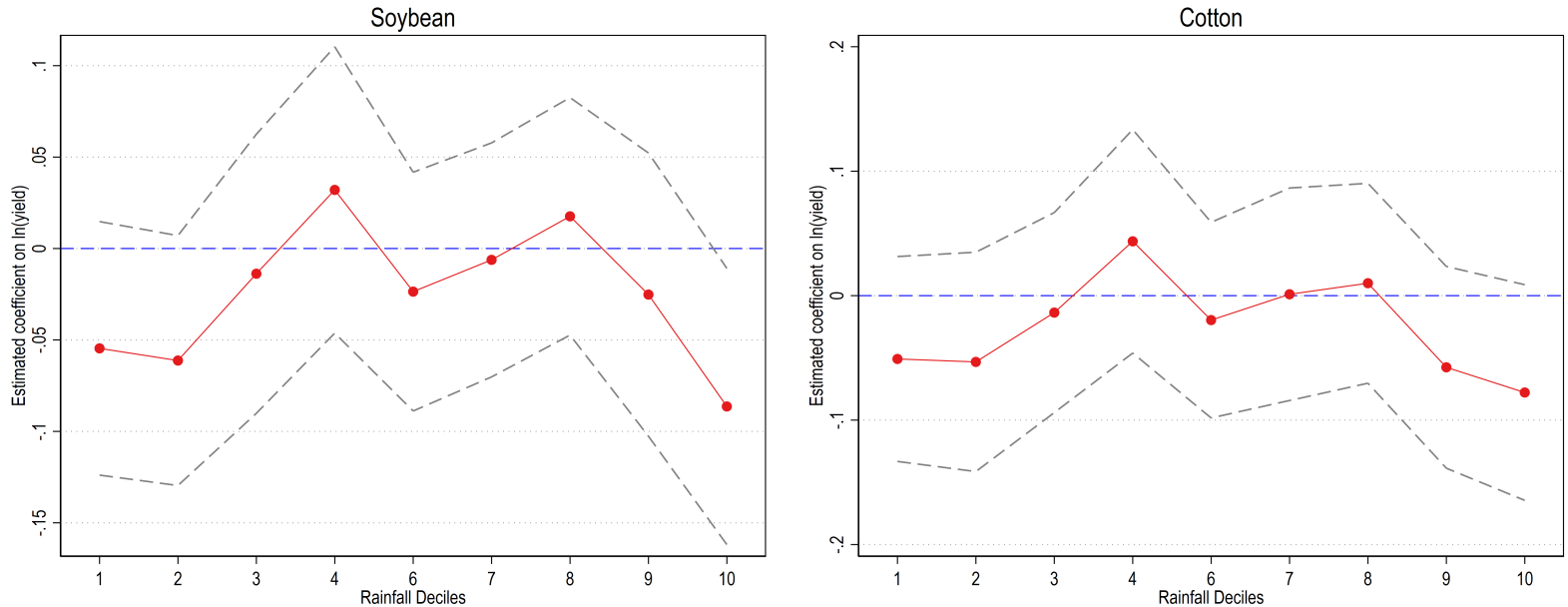
Estimated coefficient for rainfall deciles on yields



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Monthly Employment on Jharkhand's NREG, 2010-11

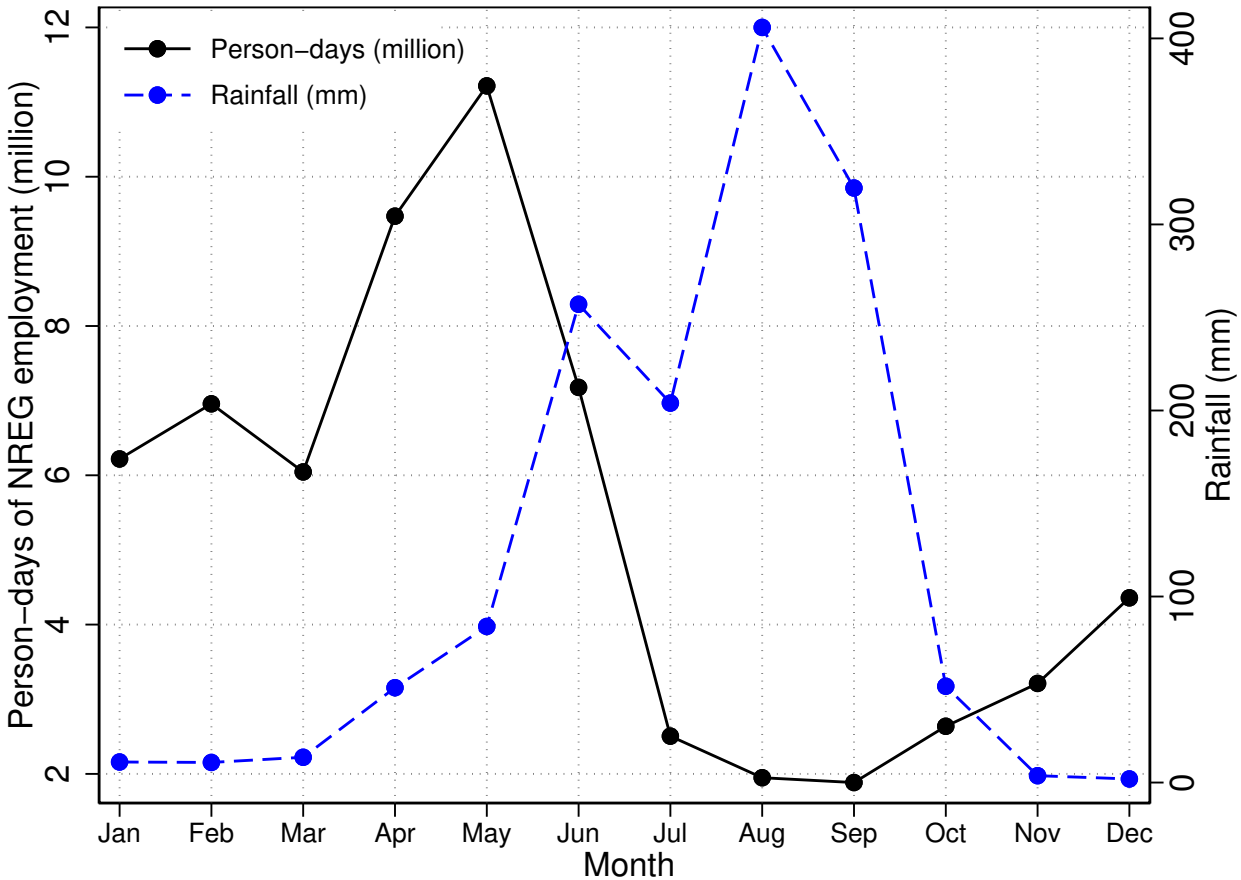

Figure: 3. Monthly Employment and Rainfall

Agricultural seasons: Peak (Jul-Dec) and Lean (Jan-Jun)

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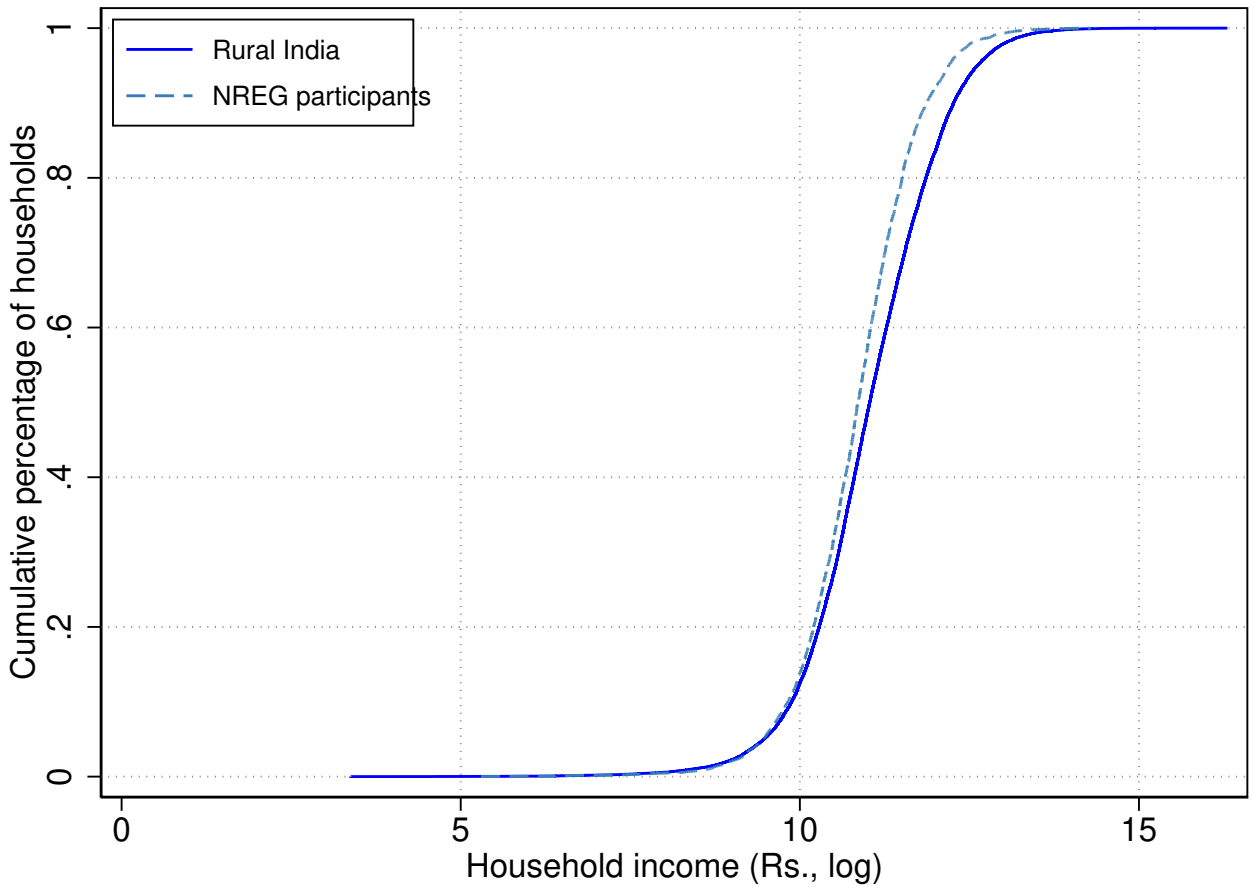
Income distribution for NREG participants and rural population as a whole, India 2004-05



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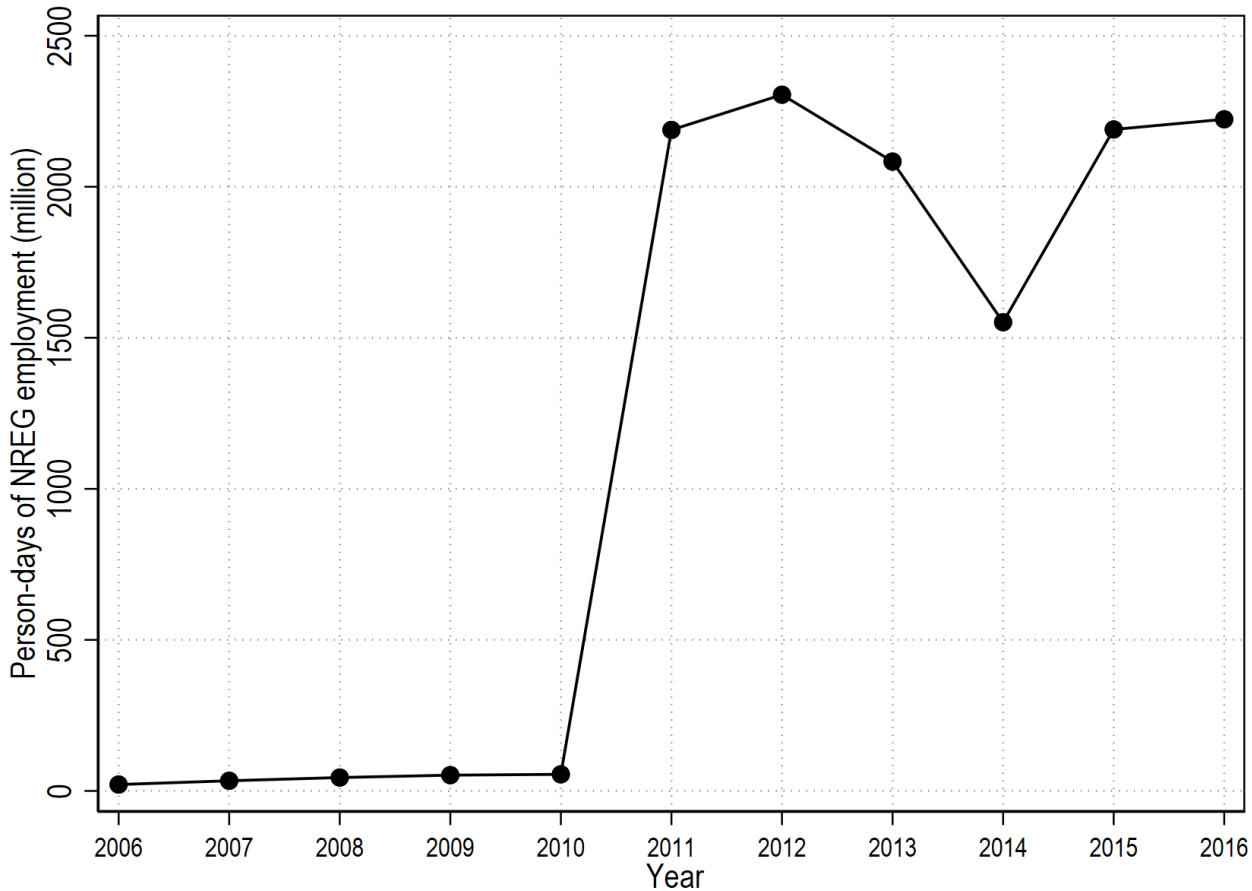
Total Employment provided by National Rural Employment Guarantee (NREG) scheme



Source: Management Information System (MIS), Government of India.

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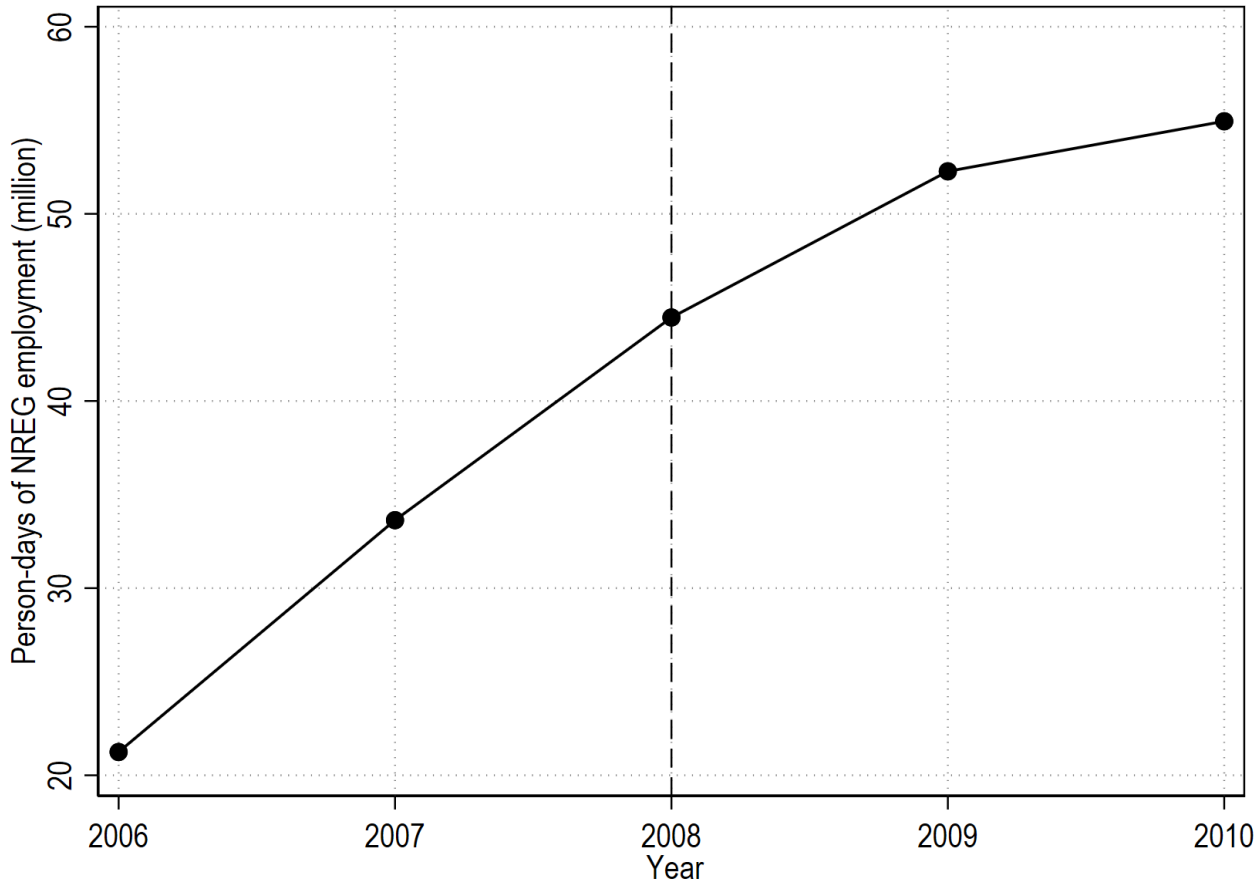
Total Employment provided by National Rural Employment Guarantee (NREG) scheme



Source: Management Information System (MIS), Government of India.

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District Level Descriptive Statistics: Rural India (2004-2012).

	Overall	Phase 1	Phase 2	Phase 3
Daily earnings: Ag (Rs.)	83.97	69.52	83.14	94.71
	(73.67)	(60.74)	(64.33)	(83.13)
Daily earnings: Non-ag (Rs.)	184.24	166.74	187.05	192.73
	(132.18)	(119.67)	(131.26)	(138.20)
Employment share: Ag	0.54	0.55	0.54	0.54
	(0.20)	(0.19)	(0.19)	(0.21)
Employment share: Non-ag	0.38	0.37	0.38	0.38
	(0.18)	(0.18)	(0.18)	(0.19)
Unemployment	0.08	0.08	0.08	0.08
	(0.09)	(0.09)	(0.09)	(0.09)
Daily Max. Temp. (°C)	32.08	32.25	32.17	32.14
	(4.04)	(3.00)	(3.49)	(4.85)
Rainfall (Kg/m2)	1296.38	1347.34	1468.26	1178.51
	(834.22)	(828.73)	(846.31)	(816.11)
Number of districts	564	195	120	226

Standard deviation in parentheses (Source: NSS EUS data).

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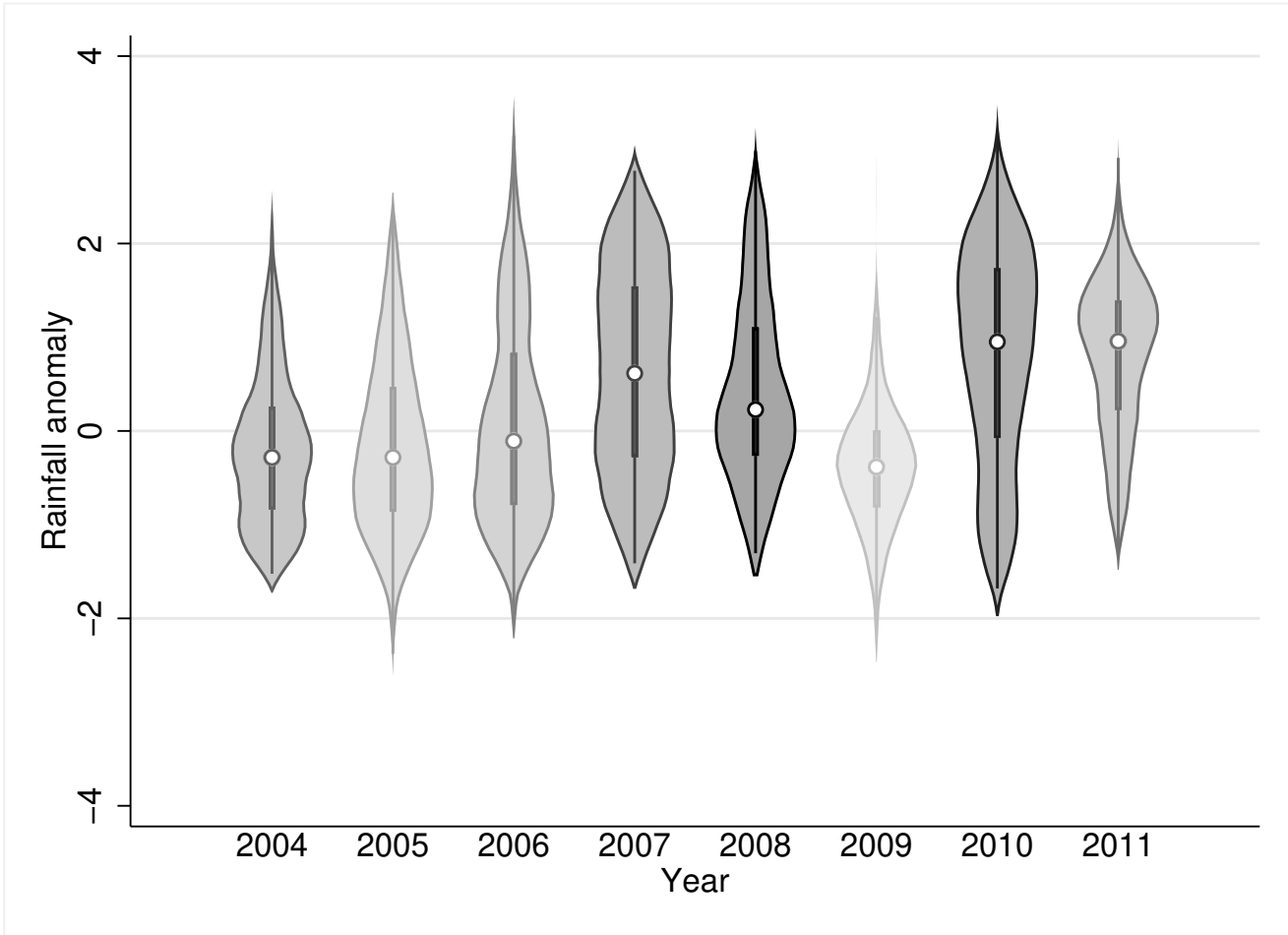
Distribution of rainfall anomalies, 2004-2011.



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Effects of weather on average daily non-farm earnings (Rs., log)

	Peak season		Lean season	
	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun
Rainfall (Kg/m2, log)	0.039	0.039	0.119	-0.028
	(0.092)	(0.083)	(0.090)	(0.073)
Degree days (DD)	-0.316	0.934*	1.274**	0.712
	(0.633)	(0.563)	(0.563)	(0.605)
Square root of Heat DD	0.024	-0.018	-0.021	0.032*
	(0.017)	(0.014)	(0.015)	(0.017)
	District and State-year FEs			
Observations	1953	1960	1955	1956
Number of districts	513	511	508	512

Conley standard errors in parentheses

return

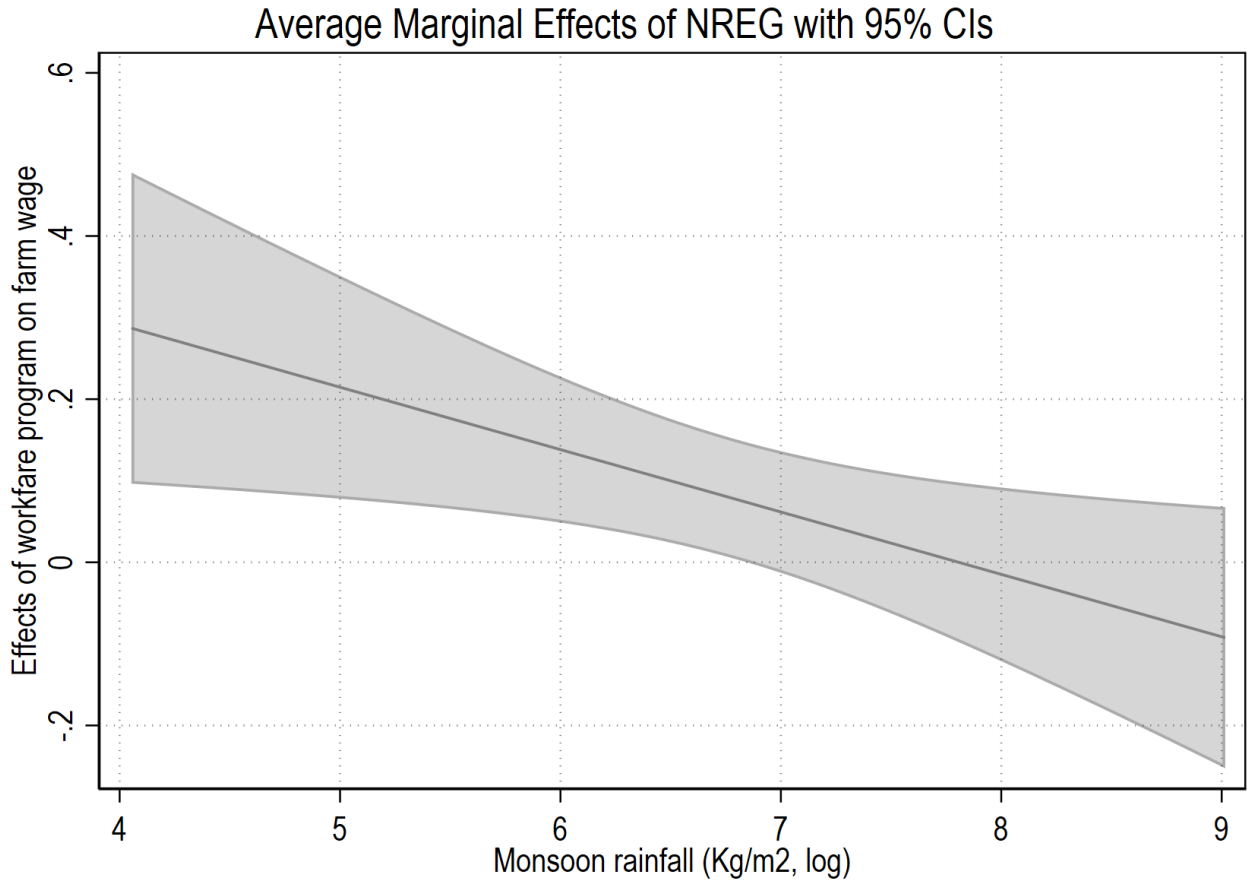
Effects of weather on share of non-agricultural employment

	Peak season		Lean season	
	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun
Rainfall (Kg/m2, log)	-0.003	-0.018	-0.002	-0.021
	(0.024)	(0.024)	(0.022)	(0.028)
Degree days (DD)	-0.225	-0.116	0.043	0.027
	(0.197)	(0.168)	(0.163)	(0.202)
Square root Heat DD	-0.008*	0.000	-0.001	0.003
	(0.004)	(0.003)	(0.004)	(0.004)
	District and State-year FEs			
Observations	2565	2560	2545	2560
Number of districts	513	512	509	512

Conley standard errors in parentheses

return

Average Marginal Effects of NREG on average daily farm earnings in quarter Oct-Dec.



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National Sample Survey Employment and Unemployment Situation (NSS EUS) round

	Year
NSS EUS Round	
61	July 2004 - June 2005
62	July 2005 - June 2006
64	July 2007 - June 2008
66	July 2009 - June 2010
68	July 2011 - June 2012
NREG phase-wise roll out	
Phase 1	January 2006
Phase 2	April 2007
Phase 3	April 2008

return

Evidence from household panel data

	All Households	Ag wage laborers
Rainfall$_{t-1}$ (log)	0.172	0.040
	(0.117)	(0.219)
Degree days$_{t-1}$ (thousands)	-0.837	-0.332
	(0.822)	(1.153)
Square root of HDD$_{t-1}$	0.051*	0.060
	(0.030)	(0.067)
NREG	0.046	-0.411
	(0.463)	(1.083)
NREG × Rainfall$_{t-1}$ (log)	-0.025	0.038
	(0.055)	(0.114)
NREG × Degree days$_{t-1}$	0.118	0.116
	(0.112)	(0.256)
NREG × Square root HDD$_{t-1}$	-0.010	-0.010
	(0.009)	(0.022)
Observations	52,698	3,838
Number of districts	280	182

Robust standard errors clustered at the district level.

return

All regressions include household and state-year FEs.